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Unstable Multi-Level Ligamentous Injury of the Cervical Spine in an Adolescent

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Abstract

Purpose: Unstable ligamentous injuries to the cervical spine are unusual within the adolescent population, being more common in younger children. Multi-level unstable ligamentous injuries are rare. Current radiological screening techniques are performed supine. These may miss the dynamic instability of such injuries when under physiological load.

Methods: We examine a case report of an adolescent suffering an atypical multi-level disc-and-ligamentous injury of the cervical spine during rugby.

Results: The instability of the injury at multiple levels was not obviously apparent on CT, MRI or supine radiographs, as per standard screening protocols, and was only revealed via sequential regular erect radiographs; requiring significant intervention in the form of sequential operations.

Conclusions: Sequential erect radiographs are useful and important in monitoring the stability of atypical cervical spine injuries under physiological load.

Background

Cervical spine injuries are a relatively rare occurrence, even within the trauma population. A literature review by Milby et al, suggested an overall incidence of 3.7% in adult patients presenting to emergency departments with trauma [1]. The incidence of cervical spine injuries within the paediatric population is even lower, with a five year review of the American National Trauma Data Bank demonstrating an incidence of 1.59% in the trauma population under 3 years of age [2]. Unstable injuries to the paediatric upper cervical spine occur even more infrequently. A single spinal centre identified 28 paediatric patients over the course of 25 years with upper cervical spine injuries requiring stabilisation; 7 (25%) of which required operative rather than/ in addition to orthotic stabilisation [3]. Of those paediatric patients suffering a cervical spine injury, adolescents are more likely to suffer vertebral fractures whilst the younger age range (< 8) are more likely to suffer soft tissue injuries, vertebral subluxation and cord injury [3,4].

A missed cervical spine injury can have significant consequences relating to secondary neural injury, deformity and chronic pain. Stringent policies therefore exist to screen and identify cervical spine trauma. These policies differ in adults and children to reflect the differences in injury pattern and where possible to avoid unnecessary increased doses of ionising radiation in the paediatric population. Within the UK, BOAST, ATLS and NICE all advocate the use of fine slice helical CT scans as standard to identify cervical injuries in high risk adults (according to the Canadian cervical-spine rules) due to their increased sensitivity over radiographs (99% vs 93%) and debate over the lower specificity of MRI scans [5-10]. MRI scans are advocated in addition in the presence of abnormal neurological symptoms/ signs. MRI scans are advocated as standard to identify cervical injuries in high risk children (due to the increased incidence of ligamentous and disc injuries over vertebral fractures in the paediatric population) with three-view radiographs advised in low risk children; with risk also defined by the Canadian cervical-spine rules. The uses of erect cervical spine radiographs are not mentioned within BOAST, ATLS or NICE, yet they are often used by spinal surgeons to determine cervical spine stability under physiological load and therefore subsequent treatment. They can identify instability in injuries thought to have no concerning features on supine CT, MRI or radiographs [11].

We present a case of an atypical soft tissue injury to an adolescent cervical spine where standard radiological screening modalities failed to identify the severity, extent and instability of the injury and where the progressive nature of the instability was only identified via serial physiological (erect) radiographs.

Case Report

A 13 year old fit and well male was playing rugby as a "forward" when a scrum collapsed on him, causing a presumed flexion-distraction injury to his neck. He sustained no other injuries. He experienced instant central neck pain and transient brief paraesthesia and loss of sensation to all four limbs. His cervical spine was immobilised on scene and he was

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taken to the local emergency department. Initially he did not mention to medical professionals his neurological symptoms experienced at the point of injury as he assumed they were secondary to lying on a cold wet rugby pitch. Examination revealed central spinal tenderness, pain on active neck movements but normal peripheral neurology with no signs of cord injury. He was treated as a low-risk cervical spine injury according to The Canadian Cervical Spine Rules. He underwent supine AP, lateral and open-mouth views of his cervical spine within a hard collar [Figure 1]. This did not reveal an obvious injury however the severity of his neck pain and a concern regarding possible disruption at the C2-3 junction resulted in a CT scan and referral to the local spinal team [Figure 2]. The CT scan did not reveal an obvious injury but again suggested possible disruption at C2-3. Following admission by the patient of his initial abnormal neurological symptoms, in conjunction with the possible concerns raised by the CT, an MRI scan was performed [Figure 3]. This demonstrated an injury to the posterior ligamentous tension band, with high signal on T2-weighted images and STIRR sequence within the inter and supra-spinous ligaments principally between C2 and C3, yet also C3 and C4, and disruption to the ligamentum flavum between C2 and 3. There was no obvious injury to the anterior and middle columns, with apparently intact vertebral bodies, anterior and posterior longitudinal ligaments and intervertebral discs. There was no signal change indicating a cord injury. Erect radiographs under normal physiological load demonstrated no displacement of the injury therefore he was managed via immobilisation within a hard cervical collar and discharged from hospital [Figure 4]. Erect radiographs within and subsequently without his cervical collar 2 weeks following his injury revealed anterior listhesis of approximately 33% of C2 [Figure 5]. He underwent C2-C3 posterior stabilisation via lateral mass screws. Great care was taken intra-operatively not to disturb adjacent levels and facets in order to prevent adjacent level destabilisation or fusion. Erect radiographs 2 weeks post-operatively revealed no abnormality [Figure 6]. Erect radiographs 4 weeks post-operatively revealed unexpected instability and anterior listhesis at C3-4 [Figure 7]. His posterior stabilisation was extended to C4 and for added post-operative immobilisation he was placed within a non-invasive Halo. Erect radiographs 6 weeks post-operatively revealed no further problems [Figure 8].

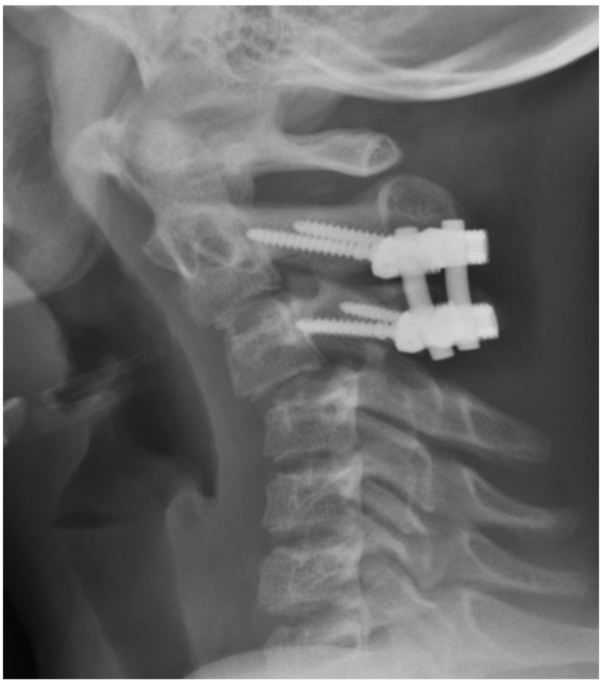

Figure 1: Initial supine screening radiographs: AP and lateral

Figure 2: CT scan: AP, lateral and axial through C2 and C3

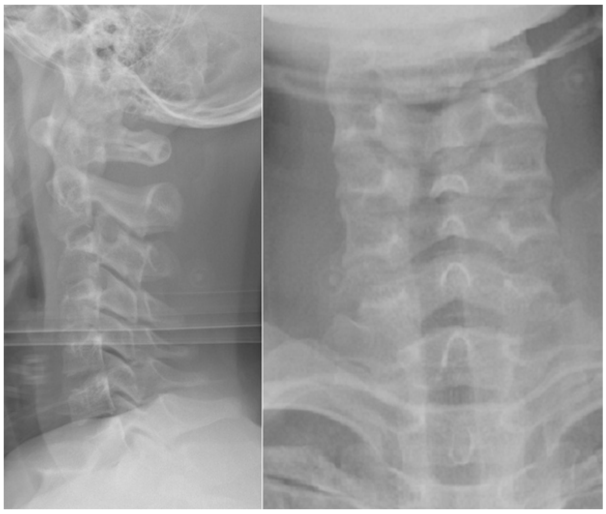

Figure 3: MRI scan: lateral T2, STIRR, axial through C2/3 and lateral T1

Figure 4: Initial erect lateral radiograph in collar demonstrating no instability

Figure 5: 2-week post-injury erect lateral radiograph demonstrating anterior listhesis of C2 in C3

Figure 6: 2 and 4-week post-index operation erect lateral radiographs demonstrating initial stability and subsequent anterior listhesis of C3 on C4 respectively

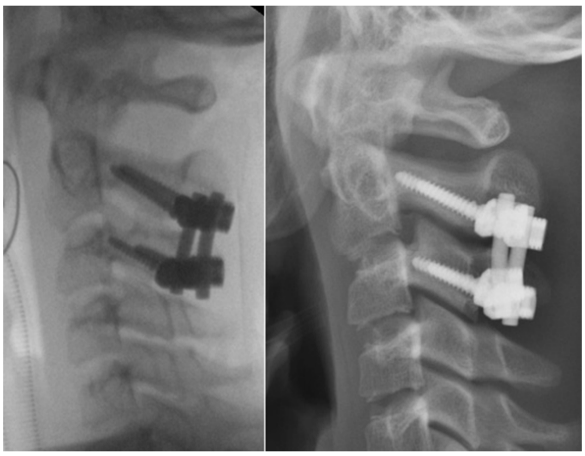

Figure 7: Minimally invasive Halo

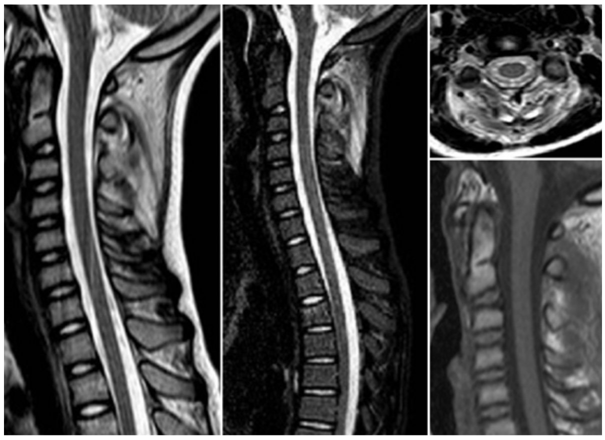

Figure 8: 6-week post-second operation erect lateral radiograph demonstrating stability

Discussion

Cervical spine injury identification and clearance can be difficult in the paediatric population [5-7]. This case was initially thought to be a low-risk injury according to the Canadian cervical spine rules, whereby a high-risk injury is defined as "a fall from a height of greater than 1 metre or 5 steps, axial load to the head – for example diving, high-speed motor vehicle collision, rollover motor accident, ejection from a motor vehicle, accident involving motorised recreational vehicles, bicycle collision, horse riding accidents". Rugby is not considered within this category. Within the paediatric population falls and dives, with sporting injuries in adolescent males, appear more prevalent in causing cervical spine injuries overall, even though motor vehicle collisions appear the commonest cause of unstable and fatal cervical spine injuries [4]. (This is as opposed to the adult population whereby motor vehicle collisions appear the commonest causative factor for cervical spine injuries overall) [1]. Due to the high incidence of paediatric cervical spine sporting injuries, and due to the increased prevalence of competitive paediatric high-impact sports (e.g. rugby, American football) perhaps greater consideration should be placed on what sporting injuries are classified as "high risk" warranting greater radiological investigation.

Missed cervical spine injuries are rare within the US and UK due to radiological screening. CT scans are advocated as gold standard in at risk adults. Certain literature has suggested that further imaging modalities are not required for identifying significant injuries and that there is no role for additional MRI imaging in a patient with no abnormal neurological symptoms, including in paediatric patients [12,13]. Alternative literature has however demonstrated that CT scans can miss significant soft tissue/ ligamentous/ discal injuries that require subsequent treatment [14,15]. This case clearly highlights this issue and the role of MRI.

It can be challenging to define cervical spine injury stability on CT or MRI as these imaging modalities are (typically) with the patient supine, and cervical spine stability by definition is identified when bearing physiological load (erect) [16]. With regard to soft tissue flexion-injuries of the cervical spine, it has been suggested that so long as the PLL and structures anterior to this remain intact, then the injury is likely to be stable and able to be treated non-operatively in extension [17]. Scrutiny of the MRI scans from this case reveal high signal within the supra and interspinous ligaments, and disruption of the ligamentum flavum at C2-3, and possibly C3-4, but no radiological evidence of disruption anterior to this. Despite this the injury destabilised in flexion. Erect radiographs, completed to screen for physiological instability, failed to initially identify instability within this injury, although were instrumental at identifying delayed instability at first C2-3 and later C3-4. Dynamic flexion-extension radiographs are argued to have no role in the screening of the injured

cervical spine as other screening modalities have higher sensitivity and specificity [18]. In a controlled setting, in the determination of stability of a soft tissue injury they may still be useful [19]. Their use is mentioned in ATLS guidelines if a clinician is concerned of an unstable soft tissue injury in adult patients in the presence of a normal CT scan, but their use is not suggested in paediatric patients, nor mentioned at all by the BOAST or NICE guidelines. It can only be speculated as to whether in this case they would have initially identified the instability at C2-3 and/or C3-4.

Concurrent contiguous fractures within the cervical spine are relatively common in cervical spine trauma. Approximately 30% of patients sustain a second traumatic cervical/ upper thoracic spine fracture in addition to the initial injury identified and an equivocal number injure the cervico-thoracic junction [18,19]. Multilevel adjacent cervical spine disc and ligamentous injury is extremely unusual, with few reports in the literature. Normally with a forced flexion injury, like this case, the force follows the path of least resistance, compressing and passing through adjacent anterior structures (adjacent vertebral body and disc) and stretching/ injuring adjacent posterior ligaments, rather than injuring neighbouring discs and not the intervening vertebral body. Fusion of a cervical motion segment is known to increase the biomechanical load through adjacent segments and predispose to future degeneration, and whilst for this case it is hypothetical that this could have contributed to revealing the adjacent level injury, it would not have caused the initial adjacent disc instability [20]. Likewise great care was taken at the index procedure not to damage adjacent levels and facet joints (principally to avoid adjacent level fusion in a paediatric patient) so an operative iatrogenic cause of the adjacent level instability is unlikely.

This case highlights both an atypical injury with progressive, adjacent level cervical ligamentous instability, and one whereby the standard cervical spine injury screening guidelines were at risk of missing, or underestimating the severity of a cervical spine injury. It demonstrates the importance of the use of regular follow-up, particularly in unusual injuries, utilising erect radiographs to monitor stability.

Declaration

I confirm that no author has any conflict of interest relating to this case report.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all individual participants included in the study.

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